

elaborately-equipped expeditions of learned societies have failed to do. It would be a pity were Mr. Stanley's exceptional aptitude for the work of exploration allowed to lie fallow. Even in the basin of the Congo much remains to be done, and we doubt if any great results will follow the Portuguese expedition which Mr. Stanley met at Loanda. There is also South America, the centre of which is now more unknown than Central Africa, and which awaits a pioneer like Stanley to show the way to the minute explorer and surveyor. It is stated that Mr Gordon Bennett contemplates equipping a polar expedition, so that we fear he thinks he has done enough for Africa. But whether or not Mr. Stanley again enters the field as an explorer, he has written his name in indelible letters alongside that of Livingstone, on the heart of Africa.

WAS GALILEO TORTURED?

Ist Galilei gefoltert worden? Eine kritische Studie. Von Emil Wohlwill. (Leipzig: Duncker and Humblot, 1877.)

THIS work treats with exhaustive thoroughness a question first raised about a century ago, as early, in fact, as advancing political liberty rendered its public discussion consistent with personal safety, and which has occupied scientific biographers pretty continuously since that time. The author's main object in reopening an issue, which the majority of recent authorities consider as settled in the negative, is to bring into due prominence the bearing on it of fresh evidence rendered accessible only within the last ten years. Up to 1867, though it was known that a detailed official record of Galileo's trial was preserved in the archives of the Inquisition, only a few isolated and questionable extracts from it had been made public. In that year, however, M. Henri de l'Épinois, by permission of the Papal authorities, published *in extenso* the most important of the documents contained in the trial-record. These, supplemented by still more recent corrections and additions, which it is unnecessary to particularise here, supplied a body of new evidence bearing more or less directly on the issue whether the Roman Inquisition, in its treatment of the great astronomer, had recourse in any degree to that test of physical endurance which formed a recognised part of its procedure as of that of contemporary secular courts in cases like his.

It was of course to be expected that in documents drawn up exclusively for the use of the Inquisition itself there would occur a number of technical expressions the exact meaning of which would be far from obvious to a reader unacquainted with the details of procedure in the holy office. This accordingly turns out to be the fact, and interposes no slight obstacle to the interpretation of the fresh evidence thus presented. Wohlwill, in order to overcome it, has put himself through an elaborate course of Inquisitional literature, studying minutely the fixed technical forms for conducting suits in the holy office laid down in manuals and instructions published for the guidance of its own officials. It is obvious how firm is the foundation thus to be secured in comparison with the precarious guessing which would otherwise be inevitable. The tasks both of preliminary inquiry and of subsequent application, have been performed with the utmost diligence, accuracy, and sagacity.

It would be impossible, within the limits of this notice, to enter upon the detailed arguments by which Wohlwill supports his views. All that can here be done is to state the chief results at which he arrives, together, where feasible, with some indication of the line by which he has travelled.

The final sentence delivered by the Inquisition in Galileo's case contains a statement that the court had judged it necessary to proceed against him to "the rigorous examination."¹ Libri had, as early as 1841, asserted, on the authority of various inquisitional manuals, and in particular of one entitled "Sacro Arsenale della S. Inquisizione," that "*esame rigoroso*"² was exactly equivalent to "torture," and that this passage of the sentence was absolutely decisive of the whole question. Wohlwill shows, by a complete scrutiny of the "Sacro Arsenale," that a "rigorous" examination in most cases meant one conducted under torture, but that this expression sometimes denoted a less severe procedure. It appears that where the course of the preliminary investigation led the judges to suspect that the accused had not stated the entire truth, three distinct and increasingly intense trials of fortitude and endurance were prescribed for successive adoption. First the prisoner was brought into the ordinary hall of audience and told briefly and sternly that unless he could make up his mind to confess the truth, recourse would be had to the torture. If this produced no result, he was next carried into the torture-chamber, where the use of the various instruments was explained to him, or he was even seized by the attendants, stripped of his clothes, and bound upon the rack, so that nothing remained but to set its machinery in action. In this situation he was again invited to save himself by confession. If he still remained firm, the infliction of the torture at once ensued. The two preliminary appeals to terror were described as the "verbal scaring" (*territio verbalis*), and the "real scaring" (*territio realis*), while the words "rigorous examination" were reserved, strictly speaking, for the final scene of actual agony. It is clear, however, from passages of the "Sacro Arsenale," that in certain cases confessions elicited by the second method of proceeding were described as made under the rigorous examination, though this laxity of expression is explicitly stated not to extend to the first. The text of the sentence against Galileo therefore implies, at the least, that he was carried into the torture-chamber and submitted to some form of the *territio realis*.

The same authoritative document informs us what was the general character of his replies under this ordeal. He answered "in a catholic manner," *i.e.*, denied that he held the reputedly heretical doctrines attributed to him. While stating this fact the Court were careful to insert a saving clause that the answers so given were not to prejudice other points admitted by or proved against the accused. The significance of this clause, which preceding writers appear to have passed unnoticed, is, according to Wohlwill, as follows:—So great was the regard professed by the Inquisition for assertions steadfastly adhered to under the torture, that in regard to whatever formed the actual subject-matter of a rigorous examination, the answers of the accused, if he thus stood by them, had to be

¹ "Giudicassimo esser necessario venir contro di te al rigoroso esame."

² Wohlwill has shown that Italian, and not, as has hitherto been assumed, Latin, was the language in which the sentence was promulgated.

accepted as true. It was therefore the interest of the Court carefully to define the limits within which it proposed to allow the accused this chance of escape. The saving clause under consideration was devised for this very purpose, so as to prevent answers made during the rigorous examination from possessing the power of voiding articles of charge or admission not explicitly included in the questions of the interrogating official. Its actual application was, of course, made at the opening of the rigorous examination as a preliminary to the torture, and the fact of the *caveat* being formally recited in the subsequent sentence is held by Wohlwill to confirm his view that Galileo was submitted at least to a *territo realis* in the torture-chamber.

After this examination of the evidence supplied by the sentence, our author next shows, in opposition to a considerable body of influential opinion, that there was nothing in the circumstances of Galileo's case to negative antecedently the application of torture, and no ascertained subsequent fact inconsistent with its having been inflicted. The absence of any reference to it in his few remaining letters of later date than the trial is completely accounted for by the oath of absolute silence imposed upon all who appeared before the tribunal of the Inquisition. The fact that Galileo was released from the custody of the Court three days after his final examination, and ten days later was able to take active exercise, shows only that severe torture was not inflicted, but by no means excludes the milder form (*leggiera tortura*), to which the Inquisitional manuals distinctly refer. The advanced age of the prisoner, who was at this time seventy, does, it is true, afford a certain degree of presumption in this direction, inasmuch as Inquisitional authorities usually incline to stop at the *territo realis* in the case of aged persons; they give, however, the alternative of applying "a kind of torture suitable to old people," so that this indication is, after all, far from conclusive.

This clearing of the ground is followed by a detailed investigation of the minutes of the trial contained in the Vatican record, so far as they bear on the question at issue. It thence appears that on June 16, 1633, Pope Urban VIII. ordered the prisoner to be interrogated as to his object in publishing his dialogues on the Ptolemaic and Copernican systems, threatened with the torture, and, if this failed to elicit a confession, condemned to abjuration and imprisonment during the pleasure of the Congregation. On June 21 this examination accordingly took place. Galileo was asked whether he held, or had held, that the earth was in motion and the sun at rest. He denied having done so since the decree of the Index on March 5, 1616, and though pressed by his interrogator with the contrary indications afforded by the dialogues themselves and repeatedly urged to tell the truth freely, clung to the denial. On being told that if he persisted further recourse would be had to the torture, he simply reiterated his former statement with this addition: "I am here in your hands, deal with me as you please." At this point the report abruptly terminates with a few words stating that nothing further could be done, followed by the signature of Galileo in attestation of his own deposition. Wohlwill points out that the threat of torture here recorded as delivered in the ordinary hall of audience cannot possibly count as a rigorous examination, since,

according to the fixed language of the Inquisition, the latter proceeding did not begin until the officials and the accused had taken up their positions in the torture-chamber. There is therefore a direct contradiction between the sentence, which affirms that a rigorous examination was held, and the official minutes, which relate nothing capable of answering to that designation. It is the deliberately expressed opinion of the German investigator that this contradiction points to a fraudulent tampering with the trial-record, perpetrated at a time when it had become advisable, in the interest of the Roman hierarchy, to obliterate, as far as possible, the traces of a mode of treatment adopted towards the great Italian astronomer which, if once allowed to become notorious, would raise a cry of indignation throughout Europe. In support of this view its author has arrayed a very strong body of evidence, many particulars of which are of singular cogency. It is indeed in this latter portion of his work, where he examines the general claims of the Vatican manuscript to be considered a complete authentic and unaltered record of Galileo's trial, that Wohlwill does the most meritorious service. An attempt to determine to what precise stage of barbarity the Inquisition advanced in its dealings with its illustrious prisoner is after all a matter of secondary interest. On the other hand an energetic effort to ascertain how far the only official account we possess of perhaps the greatest event in the whole history of science is genuine and trustworthy, must be admitted to be an undertaking of signal importance. Enough, and far more than enough, has been achieved in this direction in the present work to excite the gravest suspicions and fully to justify the warning which at its close Wohlwill addresses to the Roman authorities, that in the present condition of affairs only two courses remain open to them; either to appear as accomplices in atrocious frauds, or to bring the whole truth to the light of day. Nothing less than a thorough examination of all the remaining original records by competent and trustworthy palæographers can possibly settle the issues now definitely raised.

SEDLEY TAYLOR

The current number (January 16) of the *Rivista Europea*, which reached me after I had completed the above notice, brings a review of Wohlwill's work by Dr. Scartazzini, containing original matter due to his own independent research. The Italian critic has made strenuous use of the latest, and incomparably best, edition of the Vatican manuscript, that by Herr v. Gebler, and arrived at conclusions in regard to the falsification of its text considerably more sweeping than those based by Wohlwill on the less complete information accessible prior to the appearance of v. Gebler's edition. As far as the two writers cover the same ground they essentially agree in their verdict; the difference between them merely being that the Italian theory is more extensive than its German predecessor. It is gratifying to me to find the eminent position among historical critics to which the depth, clearness, and high originality of Wohlwill's writings on this subject in my judgment entitle him, claimed for him with equal confidence by Scartazzini. I regret that the exceedingly technical nature of the new arguments now advanced makes it impossible to give any idea of them here. They aim at pointing out the exact

nature of the excisions, transpositions, and other devices by which the Roman forger set to work to eliminate from the manuscript all trace of Galileo's having been, as Scartazzini stoutly maintains that he was, submitted to the actual torture. S. T.

THE AGRICULTURAL SOCIETY

The Journal of the Royal Agricultural Society of England. Part II., 1877.

THE current number of the Royal Agricultural Society's *Journal* is chiefly occupied with reports of the agricultural exhibitions held during the present summer at Liverpool and at Hamburg, and with reports on farms in Lancashire, Cheshire, and North Wales, which obtained the Society's prizes for good management at the Liverpool meeting. Another report deals with prize farms in Ireland in connection with the competition for small farms instituted by Earl Spencer. Besides these we have two lengthy papers on the American export meat trade, by Prof. Sheldon, of Cirencester, and by Prof. Alvord, of Easthampton, Massachusetts; three papers on village clubs, by Sir E. C. Kerrison, and Mr. Lawes; a paper on the impurities of clover seed, by Mr. Carruthers; and a short report of some investigations on foot-and-mouth disease, conducted at the Brown Institution.

The international exhibition at Hamburg was one of considerable importance: it was devoted exclusively to dairy husbandry. Lying, as Hamburg does, in the immediate neighbourhood of the great dairy countries of Northern Europe, an excellent opportunity was afforded of noting the advance made in dairy work during the last few years. The great improvement which has signalled this period is undoubtedly the use of ice in cream-setting. This invention dates from 1864, and is the work of J. G. Swartz, a Swedish farmer. In the ordinary method of cream-setting the milk is placed in very shallow pans, and stands for thirty-six hours or more while the cream is rising. The milk during this time usually turns sour, and the cream becomes contaminated with free fatty acids, with partially decomposed albuminous bodies, and with other products injurious to the flavour or keeping qualities of the butter. In Swartz's plan the milk, as soon as it reaches the dairy, is placed in deep metal pails, standing in a vessel full of ice. Not only does the low temperature reduce the process of change to a minimum, but, quite unexpectedly, it also greatly facilitates the rising of the cream; so that in pails having sixteen inches' depth of milk the cream is nearly all obtained in twelve hours. The butter churned from this sweet cream is not only very pure in flavour, but has remarkable keeping qualities. This plan, which is rapidly spreading in the north of Europe, and in the United States, is at present scarcely known in England. One obstacle to the general use of the method is undoubtedly the difficulty of procuring a sufficient supply of ice in such a climate as ours. This difficulty has been greatly diminished by the investigations of Prof. Fjord, of Copenhagen. He has shown that snow, if collected after thawing has begun, may be easily trodden into as small a compass as ice, and may be used with equal economy. The collection of snow is also far less laborious than the carting of ice, as the snow may be gathered in the imme-

diately neighbourhood of the homestead. Let us hope that English dairy farmers will not be slow to adopt the scientific methods of their continental brethren.

Statistics regarding the meat-producing capabilities of the United States and Canada are fully given by Profs. Sheldon and Alvord. The number of cattle in the United States is at present about 28,000,000, or three times as many as those in Great Britain and Ireland. The proportion of cattle to population is, in the United States and Canada, about 67:100; while in the British Isles the proportion is about 29:100. The total area of the farms in the United States is about $8\frac{1}{2}$ times that of the farmed land in the British Isles, while vast tracts of country yet remain to be cultivated. In 1875 the number of acres under Indian corn in the United States all but equalled the whole number of acres under cultivation in our own country.

With such enormous capabilities of production, the only condition wanting for a large export trade is a cheap and efficient means of transit. That such a mode of transit has now been established is proved by the quantities of meat already exported to England. We received in 1876, from New York and Philadelphia, 19,838,895 lbs. of fresh beef; and the trade has so rapidly extended, that in the first four months of 1877 the imports exceeded the whole import of the preceding year, and amounted to 22,812,128 lbs.

The means adopted to preserve so perishable an article as fresh meat during the long journey from America to England is artificial cold. The cattle are slaughtered at the port of embarkation. At the establishment in New York an ox is killed, and the skin and offal removed in the space of three minutes. The carcass is then cooled to 40° F. in a room through which a constant current of cold air is maintained from an ice chamber. After forty-eight hours the carcass is cut up, and placed in the refrigerators of the steamer, and thus conveyed to England. During the voyage a temperature of 37°—40° is maintained, a stream of dry cold air being circulated through the meat-chamber.

The source of cold has hitherto been ice, but a new cooling agent of great power and adaptability promises soon to supersede the use of ice. The invention is due to Messrs. Giffard and Berger, of Paris. In their process air is condensed by a steam-engine, the heat evolved on condensation being removed by a stream of cold water. The cool condensed air is then conveyed to the chamber which is to be refrigerated, on entering which it is allowed to expand again to atmospheric pressure. The cold thus produced is intense. The ease with which the cooling power can be conveyed to distant places, and the fact that ventilation, as well as cold, is accomplished, will probably procure numerous applications for this valuable invention.

For the extension and success of the American meat trade we now only require to erect suitable refrigerating stores, and to provide refrigerating railway-cars, for the safe conveyance and preservation of the carcass after it has reached our shores.

We have no space to refer in detail to the remaining articles. Those who feel an interest in the improvement of the agricultural labourer will find much suggestive matter in the papers on village clubs, while the kindred